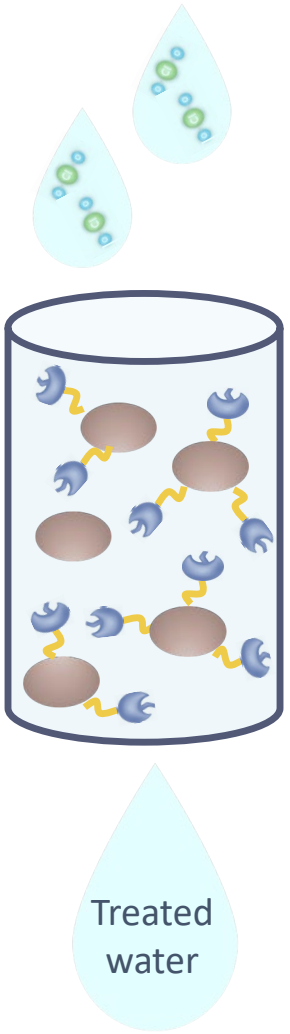
IMMOBILIZATION OF CHLORITE DISMUTASE FOR CONTINUOUS TREATMENT OF CHLORITE IN WATER SYSTEMS

Marcela Vega
Jeremy Guest
Julie Zilles

April 28, 2021

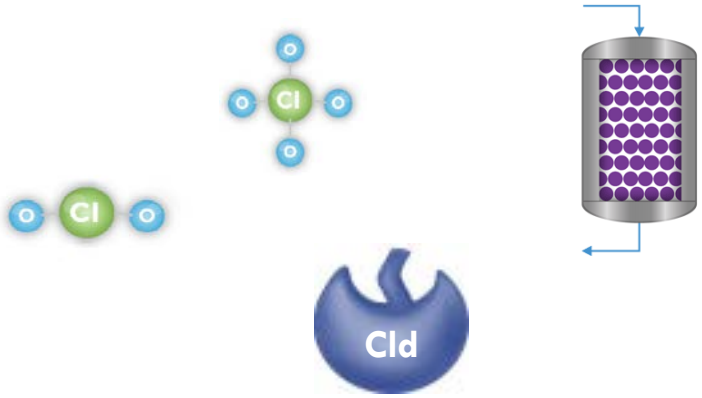


ILLINOIS

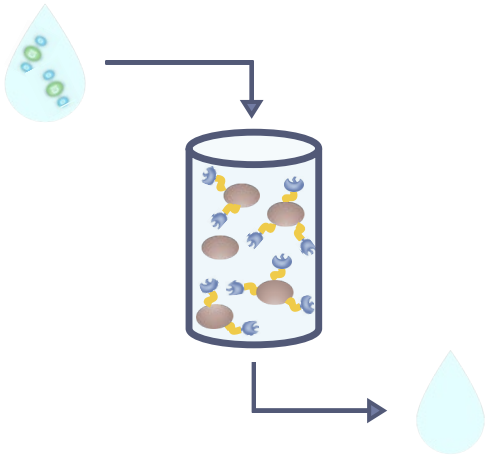
TOPICS

1. Chlorite, perchlorate,

   treatments and biocatalysis



2. Experimental work
   a. Methods
   b. Results and conclusions



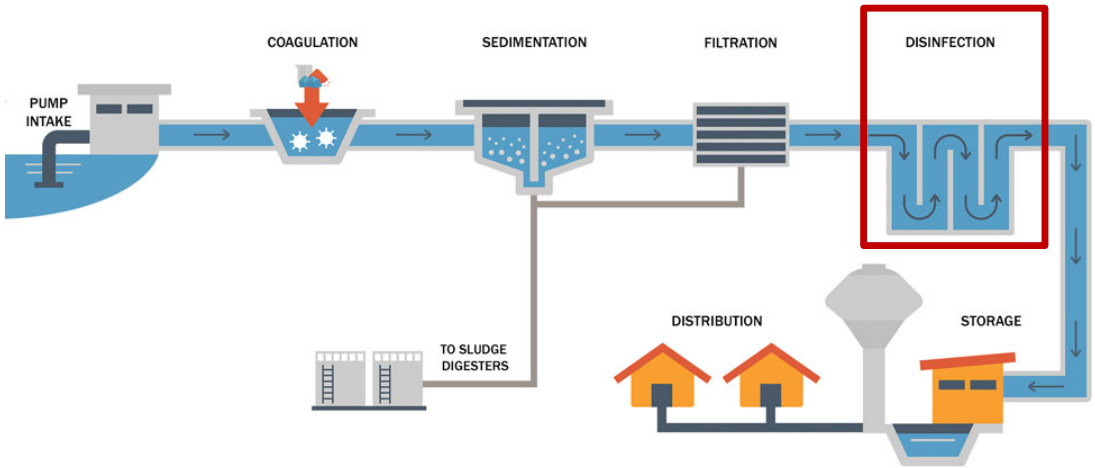
CHLORITE (ClO_2^-)

HEALTH EFFECTS AND REGULATIONS

- Oxidative damage to red blood cells

- US-EPA regulation: **1 mg/L**

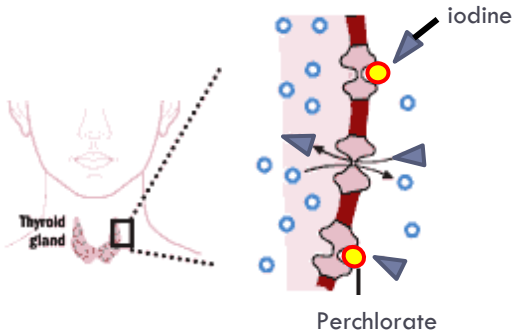
OCCURRENCE



PERCHLORATE (ClO_4^-)

HEALTH EFFECTS AND REGULATIONS

- Hypothyroidism



- Possible U.S. **federal** regulation: **18, 56 or 90 µg/L**
- State level: 2 - 18 µg/L

OCCURRENCE

Anthropogenic

Natural

New Mexico Canada

California Bolivia Chile

CURRENT TREATMENTS

CHEMICAL PROCESSES

Ferrous addition

Sentitive to pH

CURRENT TREATMENTS

CHEMICAL PROCESSES

Ferrous addition

Chemical or electrochemical reduction

Sentitive to pH

Hard conditions of T, P

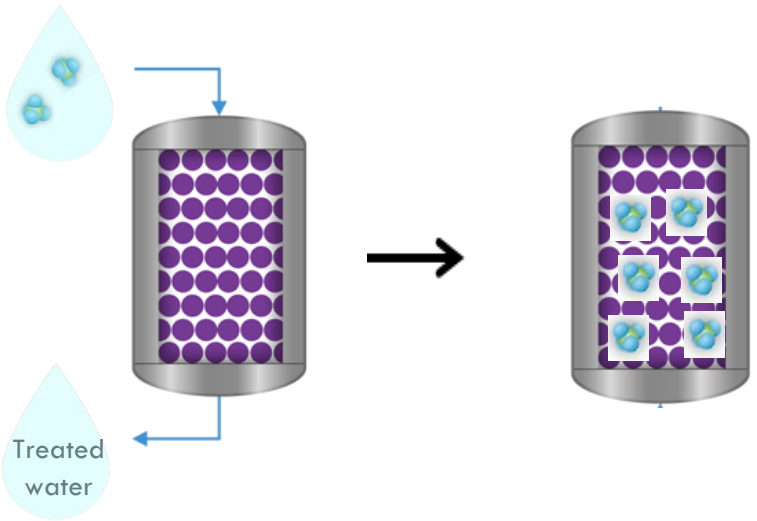
High material costs

PHYSICAL PROCESSES

Ion Exchange

Membrane filtration

Adsorption



CURRENT TREATMENTS

EMICAL PROCESSES

Ferrous addition

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Hard conditions of T, P

High material costs

Biocatalysis

PHYSICAL PROCESSES

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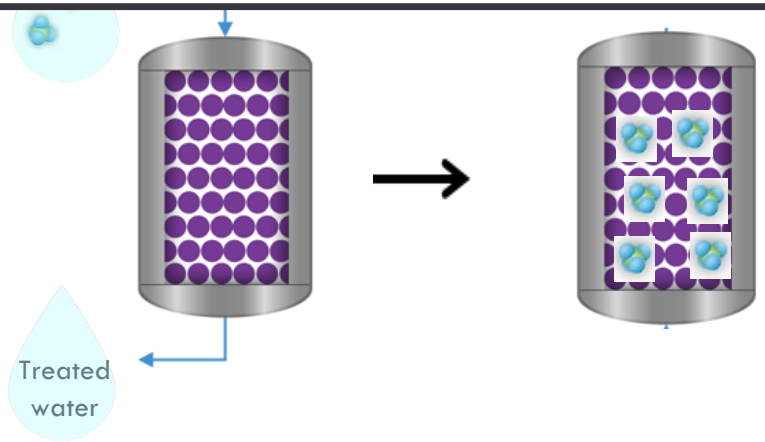
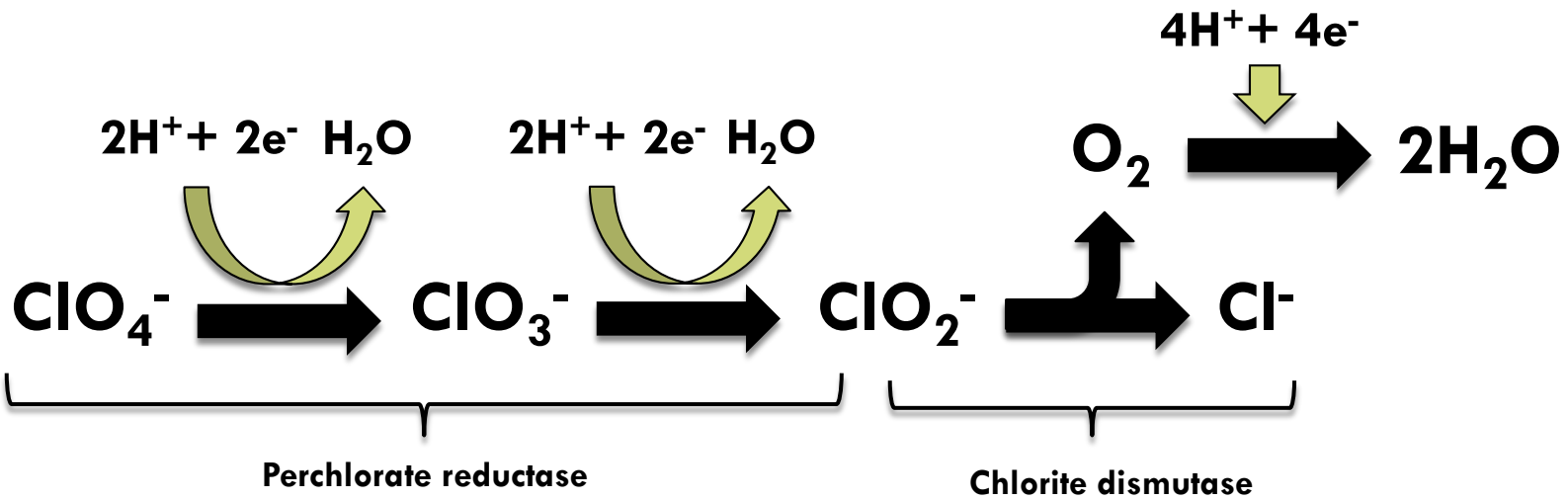


BIOCATALYSIS OF PERCHLORATE/CHLORITE

Perchlorate reducing bacteria (PRB)



Vega et al. 2018

BIOCATALYSIS OF PERCHLORATE/CHLORITE

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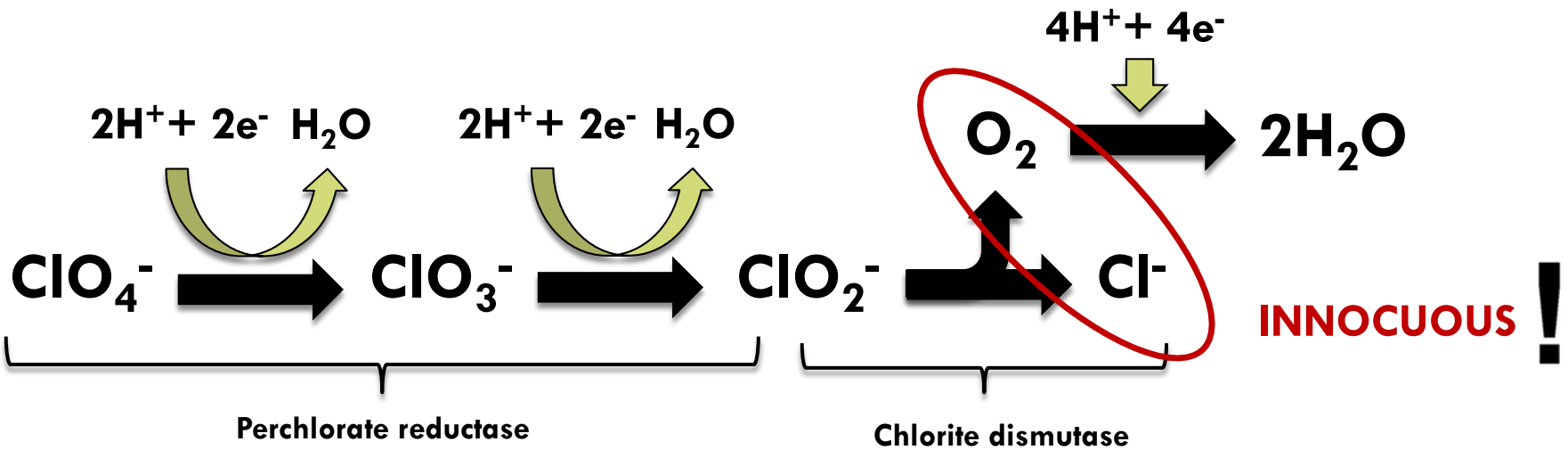
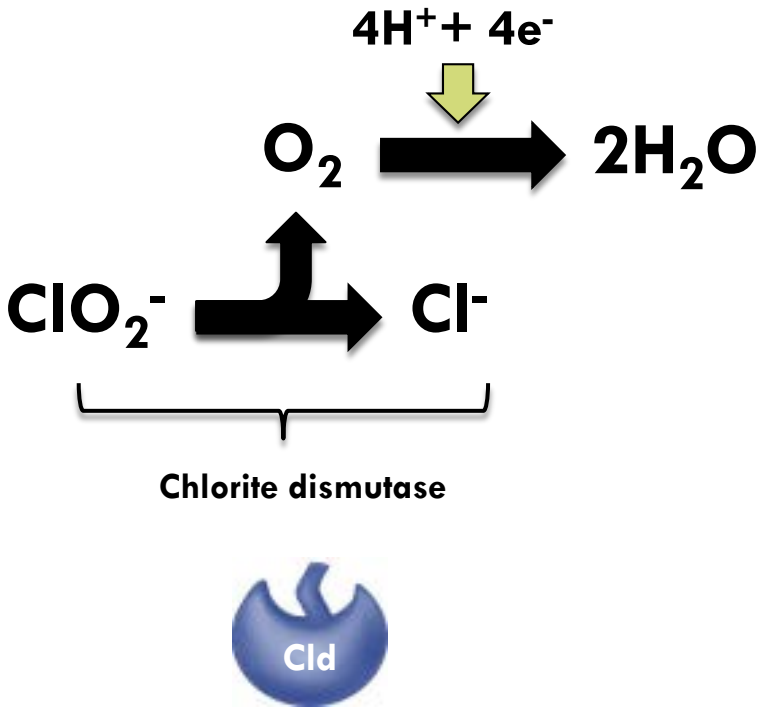
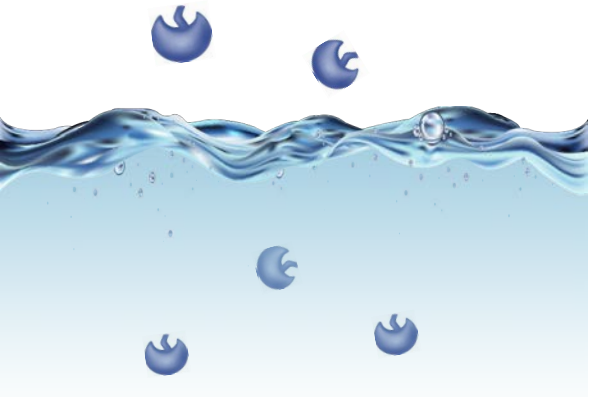


Vega et al. 2018

BIOCATALYSIS OF CHLORITE



CHALLENGES OF BIOCATALYSIS



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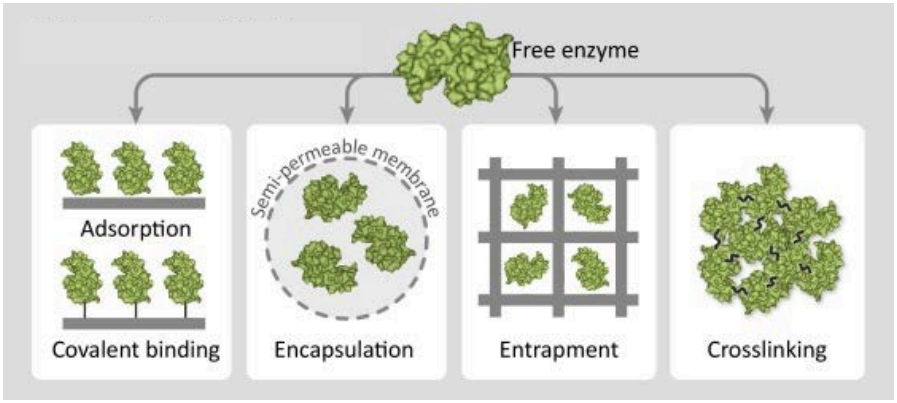
Enzymes are expensive

It is not optimal to lose them before they are inactive

IMMOBILIZATION OF ENZYMES

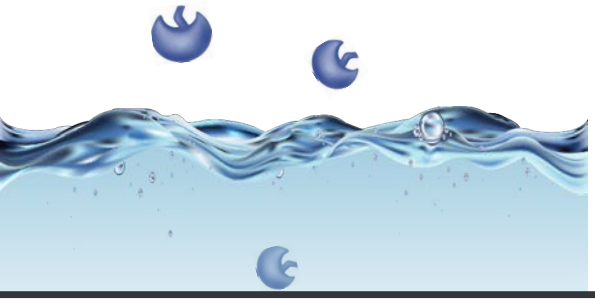


Baotong Zhu et al., 2019

☺ Reusability
May improve stability

☹ Mass transfer limitations
Decreases activity

CHALLENGES OF BIOCATALYSIS



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Enzymes are expensive

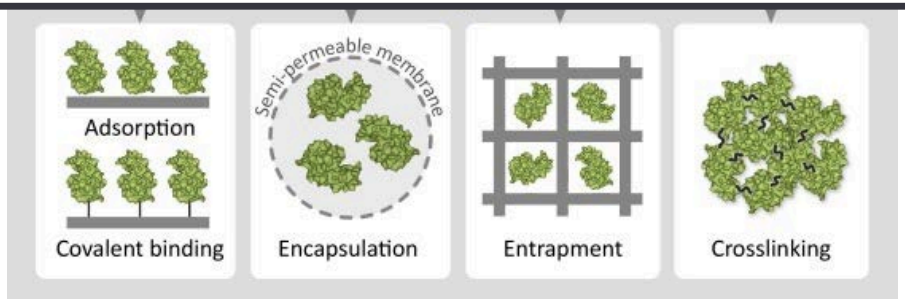
It is not optimal to lose them before they are inactive

Can Cld be immobilized?

What is the life span of Cld?

Can Cld be used in real water?

How to predict longevity?



Mass transfer limitations

Decreases activity

Baotong Zhu et al., 2019

TOPICS

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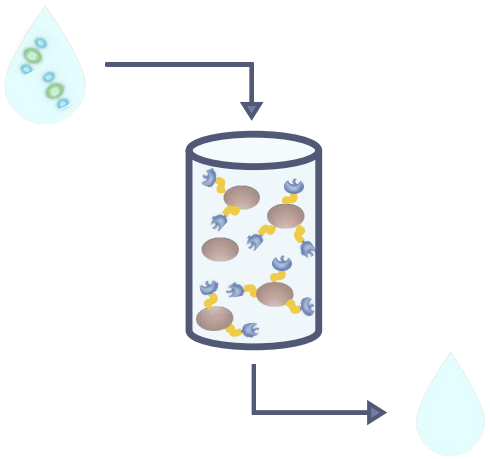
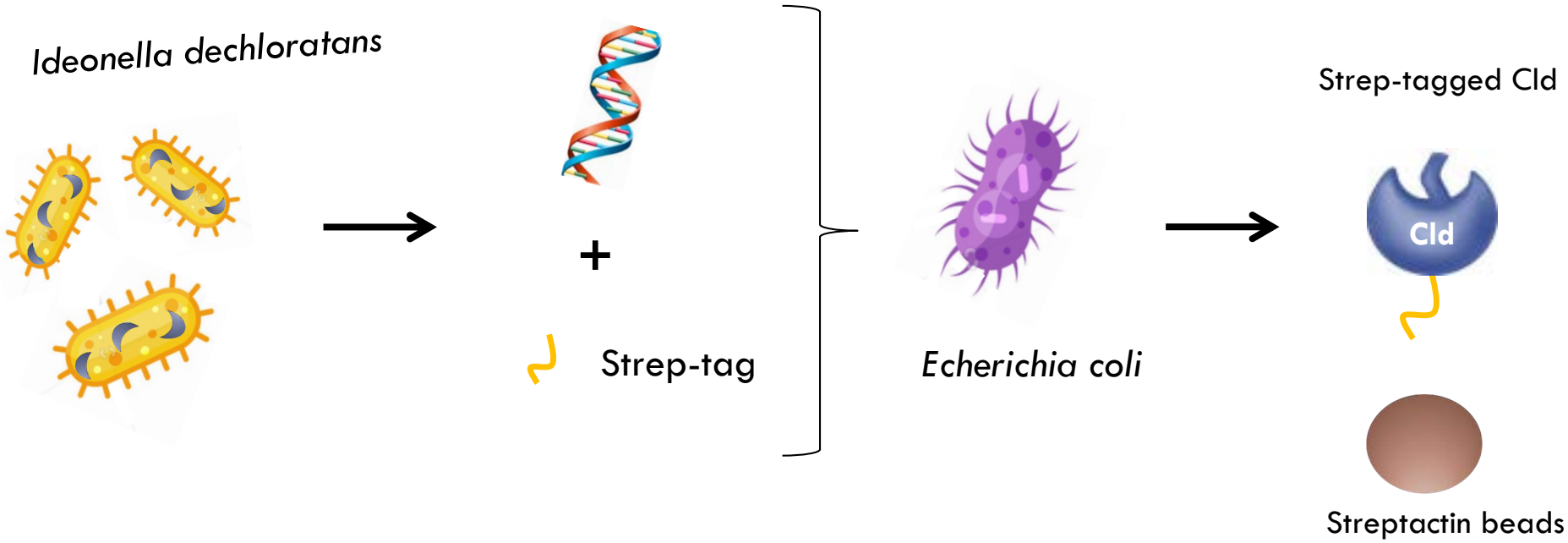


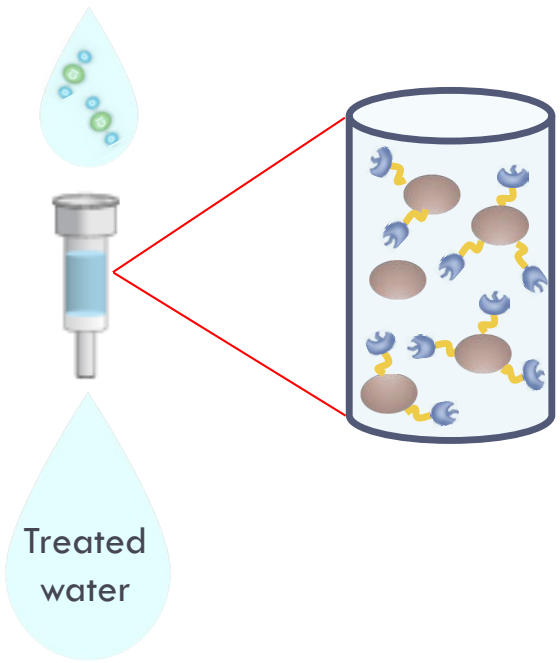
METHODS

STREP-TAGGED Cld



METHODS

ClO_2^-



EXPREMIMENTAL CONDITIONS

- 2 concentrations of ClO_2^-
- 3 amounts of Cld
- All experiments in duplicate
- Synthetic and real water

SYNTHETIC WATER

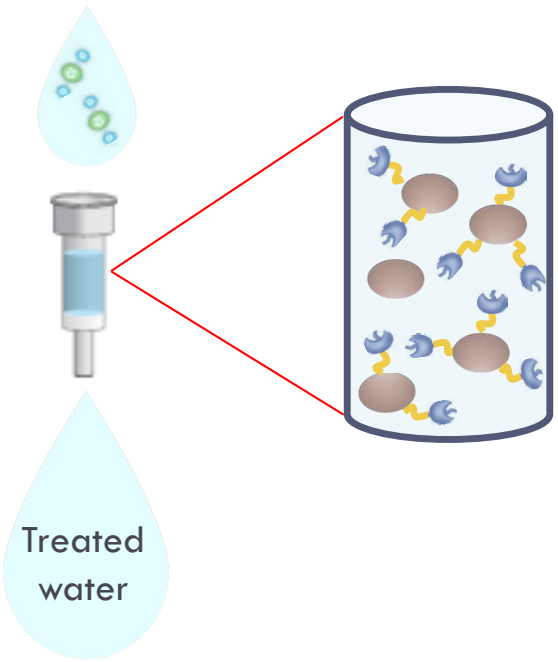
Experiment	µmol ClO_2^-/µmol heme/min
1	0.33
2	1.65
3	1.65
4	16.47

REAL WATER

Experiment	µmol ClO_2^-/µmol heme/min
1	1.65

METHODS

ClO_2^-



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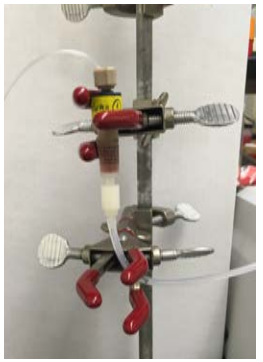
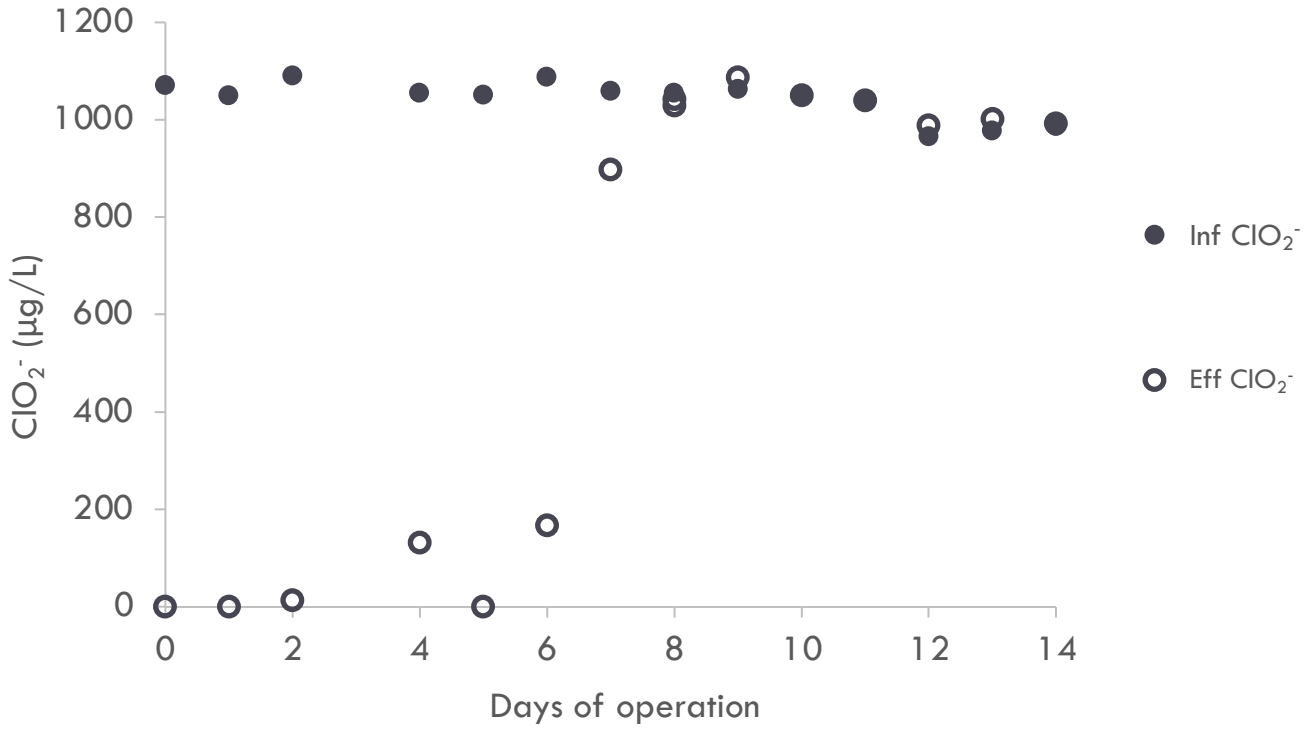


BREAKTHROUGH CURVES



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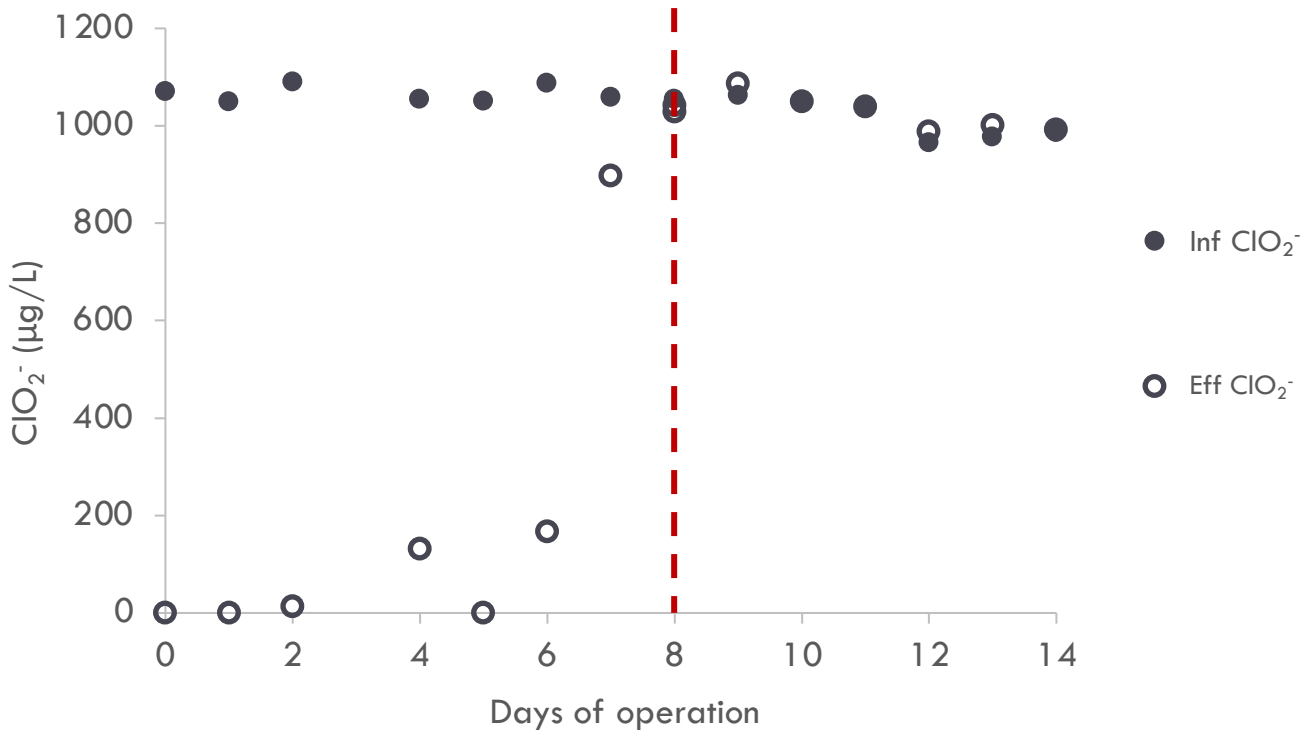

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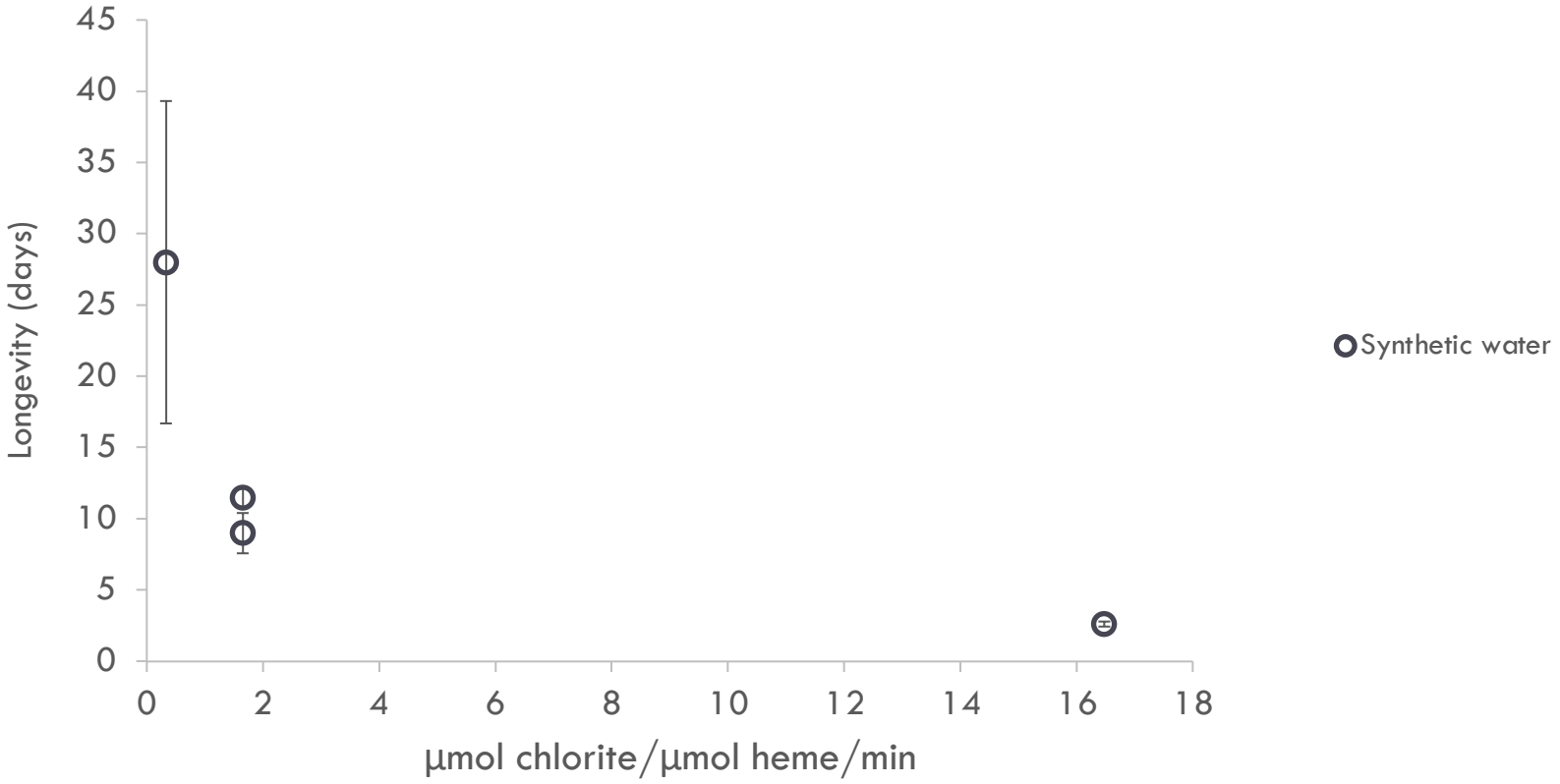
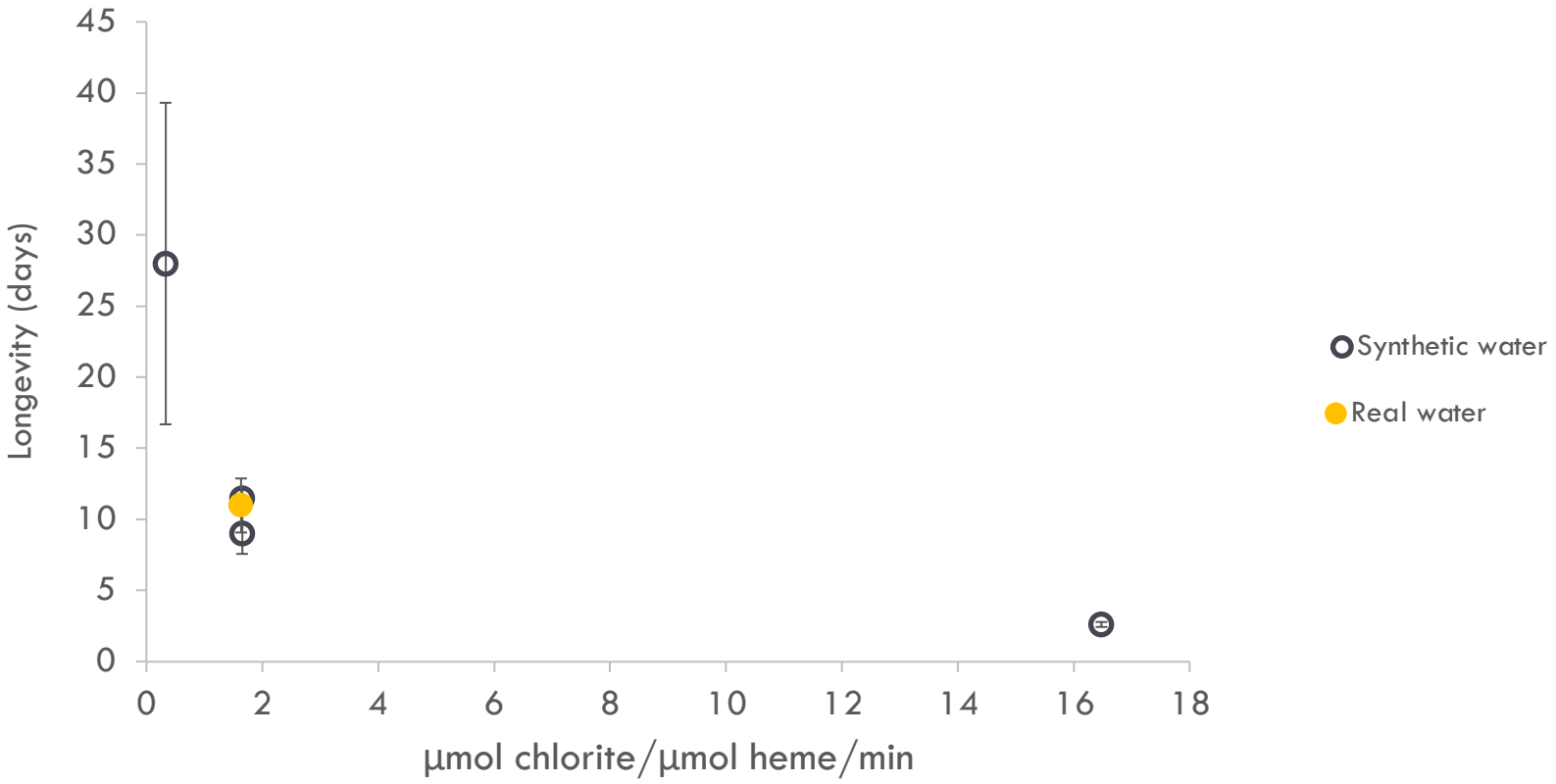

45
40
35
30
25
20
15
10
5
0
Longevity (days)
0
2
4
6
8
10
12
14
16
18
µmol chlorite/µmol heme/min
Synthetic water

RESULTS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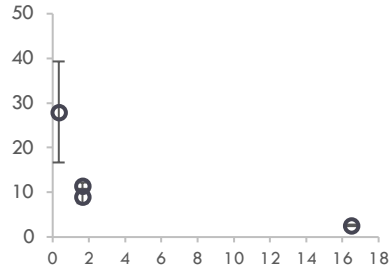
CONCLUSIONS

- Can Cld be immobilized? **Yes**
- What is the lifespan of Cld? **At least a month**
- Can Cld be used in real water? **Yes**
- How to predict longevity? **Data being used for modeling**



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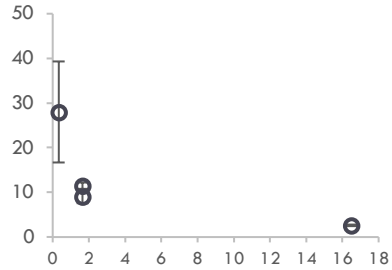
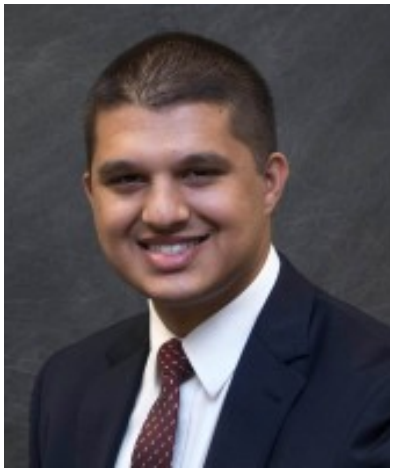


Promising results for treatment of chlorite, and eventually perchlorate, in drinking water

ACKNOWLEDGEMENT

Dr. Julie Zilles



Indran Kamalanathan

Dr. Justin Hutchison

Dr. Jeremy Guest

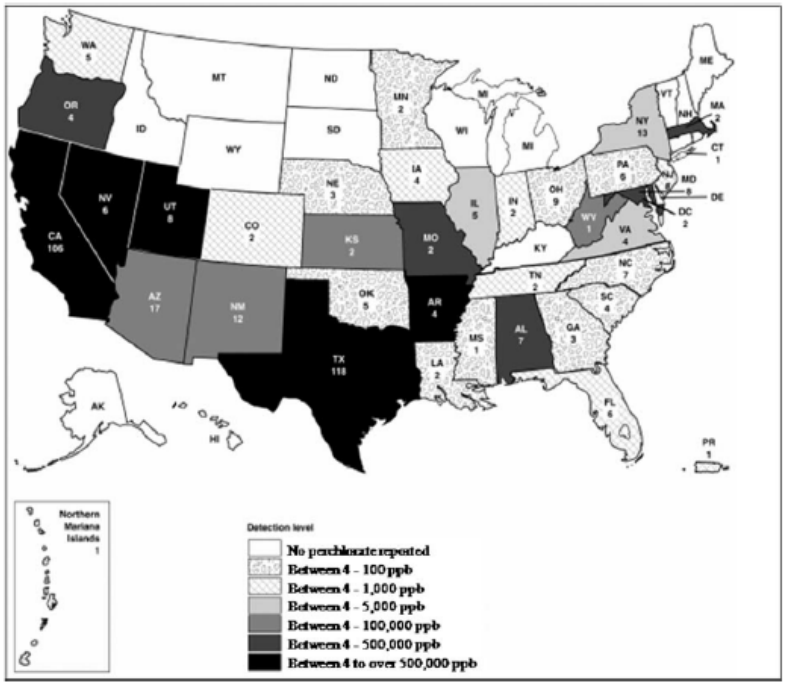
1705804

Jeremy Guest research group

THANK YOU

OCCURENCE

Anthropogenic



US GAO 2007

Natural

New Mexico

California

Canada

Bolivia

Nitrate deposits

PRB PRODUCING O_2